

# Preface

The beauty, mystery, and power of the sea fascinate people all over the world. That, of course, includes students who enroll in undergraduate courses in marine biology. For many of these students, taking a marine biology course is the natural expression of an interest in marine life that began through scuba diving, recreational fishing, aquarium keeping, or viewing the superb television documentaries. Through these interests, many students will also be concerned about the increasing impacts of humans on marine ecosystems. *Marine Biology*, Fifth Edition, was written to reinforce and enhance our readers' enchantment with marine life while providing a rigorous introduction to marine biology as a science.

*Marine Biology* is used by high school, undergraduate, graduate, and adult education students, and by interested laypersons not enrolled in formal courses. We have been delighted to learn that even some professional marine biologists find the book to be a useful general reference. While keeping this range of potential users in mind, we have written the text primarily for lower-division, non-science majors at colleges and universities. Marine biology will be the only tertiary science course that many of these students will undertake, and will often serve to satisfy a general education requirement. We have therefore been careful to provide *solid basic science coverage* including some principles of the scientific method, the physical sciences, and basic biology. Our general aim has been to integrate this basic science content with a stimulating, up-to-date overview of marine biology. We hope this approach demonstrates the relevance of the physical sciences to biology and makes the study of all sciences less intimidating. To this end, we use an informal writing style that emphasizes an understanding of concepts over rigorous detail and terminology.

We recognize that general science content will not be needed in all marine biology courses, either because the course is not intended to satisfy general education requirements or because students already have some scientific background in the sciences. To balance the needs of instructors teaching courses with and without prerequisites in basic biology or other sciences, we have designed the book to provide as much *flexibility* as possi-

ble in the use of the basic science coverage, the order in which topics are presented, and in overall emphasis and approach. We have tried to meet the needs and expectations of a wide variety of students, from the scuba-diving philosophy major to the biology major considering a career in marine science. We also hope that a variety of readers, other than university students, find the book useful and enjoyable.

Four major themes run through *Marine Biology*, one being the coverage of basic science as applied to the marine environment. Another is an *emphasis on the organisms themselves*, and their vast diversity not only in taxonomic terms but also in structure, function, and ecology. A third theme is an *ecosystem approach* that integrates this organismal diversity with the challenges imposed by the surrounding environment, both physical and biological. A final theme that, for better or worse, becomes increasingly relevant with each passing year is the *interaction of humans with the marine environment*.

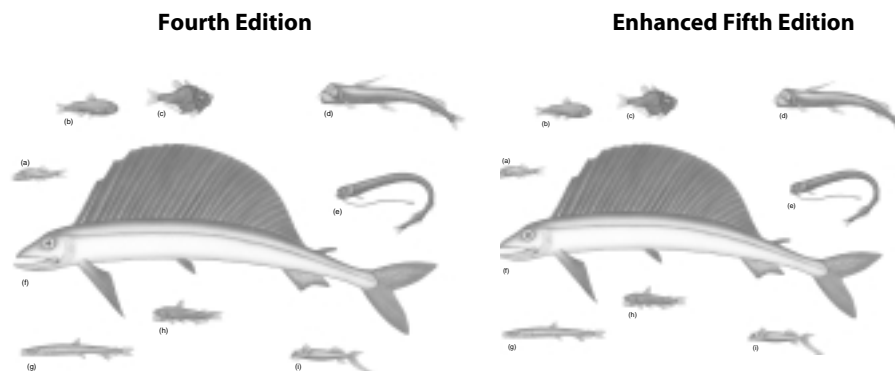
*Marine Biology*, Fifth Edition, takes a *global, non-regional perspective* to emphasize that the world's oceans and seas are an integrated system that cannot be understood by looking in any one person's own backyard. For many students this is a new perspective. One aspect of our global approach is the deliberate inclusion of examples from many different regions and ecosystems so that as many students as possible, not just in North America but around the world, will find something relevant to their local areas or places they have visited. We hope this will stimulate them to think about the many relationships between their own shores and the one world ocean that so greatly influences our lives.

## Changes in the Fifth Edition

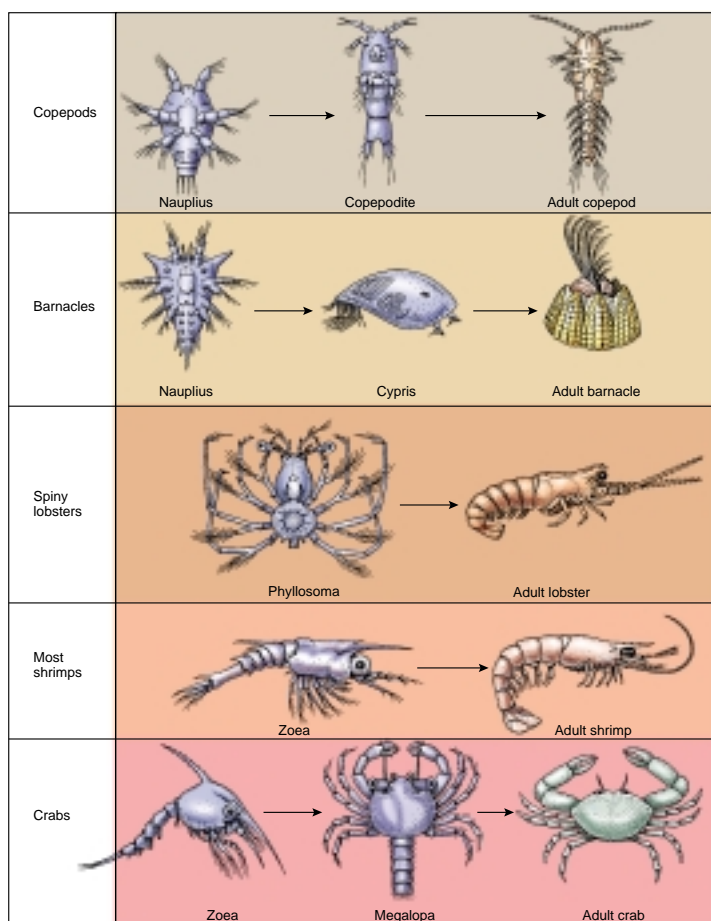
The fifth edition of *Marine Biology* incorporates *the most extensive art revision since the first edition* was published in 1991. Most of the illustrations have been improved to make them clearer, more accurate, more understandable and more attractive, using space more efficiently (see below). Many photographs from previous editions have been replaced, and others digitally enhanced. The part-opening and chapter-opening photos are all new. We have also adopted a new interior design that is more reader-friendly and makes better use of space. We hope readers are delighted with the results as we are.

As in the last edition we have *expanded our coverage of the role of microbes* in marine ecosystems in response to the steady stream of relevant new research findings. This includes incorporating the finding of organelles in some bacteria in Chapter 4, a new section and summary table in Chapter 5 on prokaryote metabolism, and updated coverage of pico- and nanoplankton in Chapter 15. We have added a *new section on larval ecology* to Chapter 10, which also contains *additional information about anthropogenic influences on global nutrient cycles* and a new figure showing the phosphorus cycle, and consolidated the description of different groups of corals and the distribution of zooxanthellae with a new table in Chapter 14. We have somewhat reduced the coverage of certain classical techniques, for example in methods of water sampling and measuring primary productivity, in favor of more modern procedures methods.

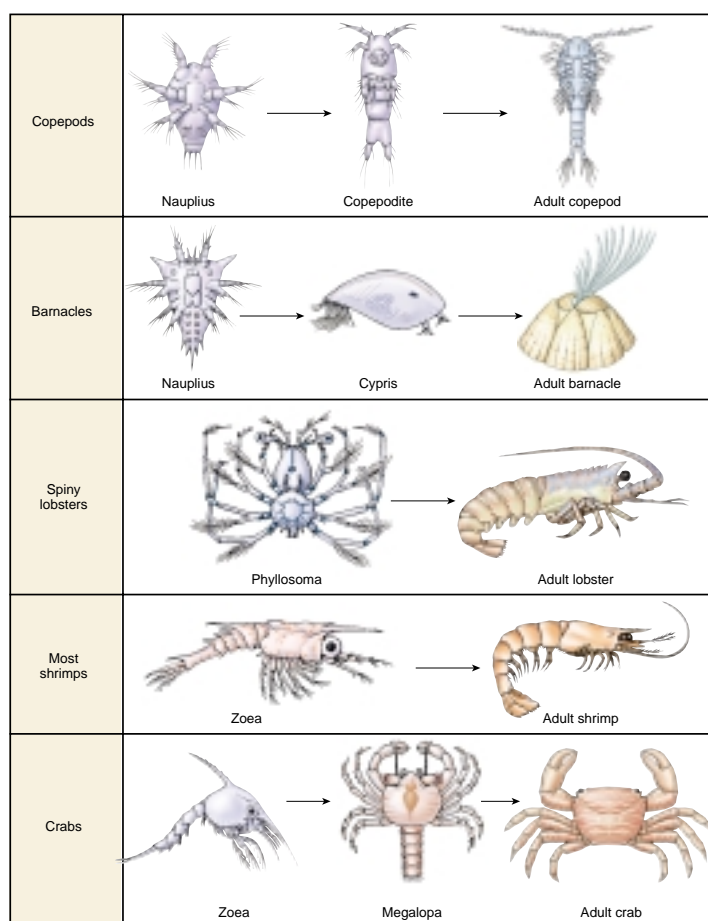
As in previous editions we have updated the text throughout to reflect *recent events, new research, changes in perspective* and to



Fourth Edition



Enhanced Fifth Edition



Fourth Edition

	Epipelagic	Mesopelagic (vertical migrators)	Mesopelagic (non-migrators)	Deep Pelagic	Deep-sea bottom
<b>Appearance</b>					
<b>Size</b>	Wide size range, from tiny to huge	Small	Small	Small	Relatively large
<b>Shape</b>	Streamlined shape	Relatively elongated and/or laterally compressed	Relatively elongated and/or laterally compressed	No streamlining, often globular in shape	Very elongated
<b>Musculature</b>	Strong muscles, fast swimming	Moderately strong muscles	Weak, flabby muscles	Weak, flabby muscles	Strong muscles
<b>Eye characteristics</b>	Large eyes	Very large, sensitive eyes	Very large, sensitive eyes, sometimes tubular eyes	Eyes small or absent	Small eyes
<b>Coloration</b>	Typical counter-shading: dark back and white or silver belly	Black or black with silver sides and belly; counter-illumination	Black or black with silver sides and belly; counter-illumination	Black, occasionally red	Dark brown or black
<b>Bioluminescence</b>	Bioluminescence relatively uncommon	Bioluminescence common, often used for counter-illumination	Bioluminescence common, often used for counter-illumination	Bioluminescence common, often used to attract prey	Only a few groups bioluminescent

Enhanced Fifth Edition

	Epipelagic	Mesopelagic (vertical migrators)	Mesopelagic (non-migrators)	Deep Pelagic	Deep-sea bottom
<b>Appearance</b>					
<b>Size</b>	Wide size range, from tiny to huge	Small	Small	Relatively small, larger than mesopelagic	Relatively large
<b>Shape</b>	Streamlined	Relatively elongated and/or laterally compressed	Relatively elongated and/or laterally compressed	No streamlining, often globular in shape	Very elongated
<b>Musculature</b>	Strong muscles, fast swimming	Moderately strong muscles	Weak, flabby muscles	Weak, flabby muscles	Strong muscles
<b>Eye characteristics</b>	Large eyes	Very large, sensitive eyes	Very large, sensitive eyes, sometimes tubular eyes	Eyes small, sometimes absent	Small eyes
<b>Coloration</b>	Typical counter-shading: dark back and white or silver belly	Black or black with silver sides and belly; counter-illumination	Black or black with silver sides and belly; counter-illumination	Black, occasionally red, often lack coloration at greatest depths	Dark brown or black
<b>Bioluminescence</b>	Bioluminescence relatively uncommon	Bioluminescence common, often used for counter-illumination	Bioluminescence common, often used for counter-illumination	Bioluminescence common, often used to attract prey	Only a few groups bioluminescent

include information requested by reviewers. The fifth edition presents new information about the Tethyan fauna, past climate variability, hot spots in the earth's mantle, Antarctic upwelling, nucleic acids, viruses, fisheries, cleaning associations, the taxonomic

position of pogonophorans, *Pfiesteria*, osmotic regulation in fishes, indirect ecological interactions among species, shark attacks, bioerosion on coral reefs, coral bleaching, epipelagic cyanobacteria, endangered marine species, temperature regulation in "warm

blooded" fishes, hydrothermal vents, benthic diversity on seamounts, and many other topics. As usual we have updated facts and figures, corrected errors, and reorganized some sections to improve balance and logic flow.

## Organization

*Marine Biology* is organized into four parts. Part 1 (Chapters 1 through 3) introduces students to marine biology and related fields of science. Chapter 1 describes the history of marine biology. It also covers the fundamentals of the scientific method, which are essential in understanding how science works. This feature presents science as a process, an ongoing human endeavor. We believe it is important for students to realize that science has limitations and that there is still much to be learned. Chapters 2 and 3 present basic material in marine geology, physics, and chemistry. *Marine Biology* includes more information on these subjects than other texts, but we have kept Chapters 2 and 3 as short as possible and cover many physical and chemical aspects of marine environment in the chapters where they are most relevant to the biology. Wave refraction, for example, is covered in conjunction with intertidal communities (Chapter 11) and estuarine circulation is discussed as part of the ecology of estuaries (Chapter 12). This approach provides general science coverage for instructors who need it, while allowing other instructors to use these chapters for background reference. It also emphasizes the importance of the physical and chemical environment to the organisms of the sea. Like the rest of the book, Chapters 2 and 3 include original world maps that were drawn using the Robinson projection to minimize distortion.

Part 2 (Chapters 4 through 9) takes a close look at the diversity of marine organisms. Chapter 4, “Some Basics of Biology,” is a brief introduction to basic biology aimed at students with a limited background in biology. As with the fundamentals of geological, physical, and chemical oceanography, these basic biological concepts are reviewed throughout the book in “In-text Glossary” entries that remind students of the definitions of key terms. Because the most important material is reviewed in these boxes, Chapter 4 may be omitted if students have an adequate background in basic biology. Chapters 5 through 9 survey the major groups of marine organisms from the perspective of organismal biology. As in the first part of the book, we provide introductory information that is reviewed and expanded upon in later chapters. In discussing the various groups of or-

ganisms, we emphasize functional morphology, ecological and physiological adaptations, and economic importance or significance to humanity. Classification and phylogeny are not stressed, although a general classification scheme is presented in graphical form at the beginning of each chapter. Here and throughout the book we selected organisms from around the world for illustration in photographs, line drawings, and color paintings, but organisms from the coasts of North America are emphasized. Organisms are referred to by their most widely accepted common names; one or two common or important genera are noted in parentheses the first time a group is mentioned in a chapter, but we have not attempted to be comprehensive in listing genera. Nomenclature follows for the most part the FAO Species Catalog and Species Identification Guides for groups covered by these references.

The third part of the book (Chapters 10 through 16) presents an ecological tour of the major environments of the world ocean, commencing with an introduction to some fundamental principles of marine ecology in Chapter 10. As for Chapter 4, important concepts presented here are reviewed elsewhere in the In-text Glossary boxes. The remaining six chapters of Part 3 proceed from nearshore to offshore and from shallow to deep water, describing the physical characteristics of each environment and the adaptations and interactions of the organisms that live there. This sequence is admittedly arbitrary but conforms to the teaching sequence followed by the greatest number of our reviewers. The chapters, however, are designed so that they can be covered in any sequence according to instructors’ preferences and needs. Most chapters include generalized food webs that follow a standardized scheme of color coding to indicate the nature of the trophic relationships.

The final part of the book looks at the many ways in which humans interact with the world ocean: our use of and impact on the marine environment, and the influence of the ocean on culture and the human experience. These chapters present an up-to-date, comprehensive view of issues and concerns shared by many students. The chapter on resource utilization (Chapter 17) looks not only at traditional uses such as fisheries and mariculture, but also at more modern aspects such as the pharmacological use of marine natural

products and the application of genetic engineering to mariculture. In Chapter 18, a discussion of human-induced degradation of the marine environment is balanced by an examination of the conservation and enhancement of the marine environment. The book closes with an essay on the impact of the ocean on human affairs (Chapter 19) that we hope will stimulate students to reflect on the past and future significance of the world ocean.

## Teaching and Learning Aids

Because courses vary in content and sequence, *Marine Biology* was designed to be a flexible and efficient teaching aid. Chapters are written as short, readily absorbed units to increase instructors’ flexibility in selecting topics. It is not assumed that instructors will follow the order in which material is presented in the book. For this reason, we provide an **In-text Glossary** that briefly explains key terms and concepts from other chapters. Some are illustrated by line drawings. Each box refers to the chapter and page where the concept is explained if more detailed information is needed. We hope this feature reduces the distraction of searching the index for unfamiliar terms.

**Key concept summaries**, printed in italics, highlight the most important terms and ideas presented in preceding paragraphs. The text is accompanied by a superb collection of photographs and illustrations that were carefully designed and selected to complement and reinforce the text. Some of their captions contain questions that seek to further stimulate the student. There are many maps specifically created for *Marine Biology* to our specifications. The extensive **Glossary** provides complete definitions, and often refers to illustrations in the text or other key terms in the glossary that help explain a concept.

All chapters contain short **Boxed Essays** that present interesting supplementary information—material as varied as experimental setups, John Steinbeck, intelligence in dolphins, and marine archaeology.

Each chapter concludes with material to promote students’ **Interactive Exploration** of topics covered in the chapter. This material is specifically designed to be used in conjunction with the book’s **Online Learning Center**. Several **Critical Thinking** questions are posed at the end of each chapter to challenge

students and stimulate class discussion. Many of these have no “right” answer—that is often the point. A brief annotated list of recent readings, **For Further Reading**, is provided for students who want to learn more. As in previous editions the list includes richly illustrated **General Interest** articles in publications such as *Scientific American*, *Discover*, and *National Geographic* that are appropriate for students with limited backgrounds in science. A list of **In Depth** readings is also provided as a starting point for students who want to study particular topics in detail. An icon indicates articles that can be freely accessed online, and links to the articles are provided within the Marine Biology Online Learning Center. Students can use the online **Do-It-Yourself Summary**, **Key Terms** flashcards, and **Quiz Yourself** resources to review the chapter and test their understanding. The Online Learning Center also provides links to web sites related to each chapter. For most chapters the Online Learning Center also provides short video clips showing interesting habitats and animal behaviors.

## Ancillaries

**Instructor’s Manual.** Prepared by Peter Castro, this helpful ancillary provides chapter outlines and summaries, a listing of audiovisual materials and software that complement each chapter, and answers to the Critical Thinking Questions within the text. Instructors will also find suggestions on how to present concepts to students and how to organize materials for class presentation. The Instructor’s Manual is available in the Online Learning Center, within the Instructor Resources, at [www.mhhe.com/marinebiology](http://www.mhhe.com/marinebiology) (click on this book’s cover).

**Test Item File.** This user-friendly computerized testing software includes 470 multiple-choice questions and answers, sorted by chapter. The Test Item File is available as a CD-ROM, and is available free of charge to instructors using the textbook.

**Digital Content Manager.** Available on CD-ROM, instructors will have access to the **Digital Content Manager (DCM)**. This multimedia collection of visual resources allows instructors to utilize artwork from the text in

multiple formats to create customized classroom presentations, visually-based tests and quizzes, dynamic course website content, or attractive printed support materials. The digital assets on this cross-platform CD-ROM are grouped by chapter within easy-to-use folders. On the CD-ROM version of the Digital Content Manager, instructors will have access to video segments from Scripps Institution of Oceanography, grouped by chapter to go with the fifth edition of this text.

**Transparencies.** A set of 75 full-color overhead transparencies of key illustrations from the text is available to instructors.

**Laboratory Manual.** *Laboratory and Field Investigations in Marine Life*, Seventh Edition, by James L. Sumich and Gordon Dudley, is a manual written specifically for a one-semester course. Each of the fifteen laboratory exercises in this collection has been designed for approximately a 3-hour laboratory period. Suggested topics for further investigation are also incorporated into the exercises. A collection of field studies, as well as six informative appendices, can be found at the back of this manual.

**Marine Biology Online Learning Center.** This text-specific website allows students and instructors from all over the world to communicate. Instructors can create a more interactive course with the integration of this site, and students will find many tools to help them improve their grades and learn that marine biology can be fun. Check out the Online Learning Center for this text at [www.mhhe.com/marinebiology](http://www.mhhe.com/marinebiology) (just click on this book’s cover).

## Acknowledgments

Bill Ober and Claire Garrison have done a wonderful job of bringing new life to the illustrations in the fifth edition and it has been a pleasure to work with them. The new design by Jim Gibson and David Hash is a delight to the eye. We also thank the many contributors of photographs that add so much to the book, especially A. Charles Arneson, who has provided many excellent photos, and appreciate the diligent efforts of LouAnn Wilson in locating new photos.

We are grateful to the editorial staff at McGraw-Hill Publishers, particularly Marty Lange, Fran Schreiber, Developmental Editor, Jayne Klein, Project Manager, and Karen Dorman, copy editor, for their patience, support, and efficiency in managing an enormous amount of detail.

Most of all we thank the students, friends, colleagues, former teachers, and reviewers who answered questions, pointed out errors, and made suggestions that have greatly improved the book. We take full credit, however, for any errors or shortcomings that remain.

## Reviewers

The following people have reviewed the fourth edition, and have provided useful commentary for preparation of the fifth edition.

Linda Armstrong  
*State University of New York at Sullivan*  
 Claude D. Baker  
*Indiana University Southeast*  
 William Berry  
*University of California—Berkeley*  
 Randy Brooks  
*Florida Atlantic University*  
 Lisa Campbell  
*Texas A&M University*  
 Gerardo Chin-Leo  
*The Evergreen State College*  
 Bob Cullison  
*Community College of Baltimore County—Essex*  
 Thomas C. Dunstan  
*Western Illinois University*  
 William Wayne Falls  
*Hillsborough Community College*  
 Louis F. Gainey, Jr.  
*University of Southern Maine*  
 Robert R. Given  
*Marymount College*  
 Peter W. Glynn  
*Rosenstiel School of Marine & Atmospheric Science, University of Miami*  
 Dennis C. Haney  
*Furman University*  
 Patrick James Leary  
*Community College of Southern Nevada*  
 Wei-Jen Lin  
*California State Polytechnic University*  
 Madhumi Mitra  
*University of Maryland Eastern Shore*

Karla J. McDermid  
*University of Hawaii at Hilo*  
Madhuri Mitra  
*University of Maryland Eastern Shore*  
John L. Moss  
*Santa Monica College*  
Christopher M. Pomory  
*University of West Florida*  
Marjorie L. Reaka-Kudla  
*University of Maryland*  
Robert H. Reavis  
*Glendale Community College (Arizona)*

Wendy L. Ryan  
*Kutztown University of Pennsylvania*  
Erik P. Scully  
*Towson University*  
Florence Thomas  
*University of South Florida*  
Timothy S. Wakefield  
*John Brown University*  
Raymond Waldner  
*Palm Beach Atlantic University*  
Mary K. Wicksten  
*Texas A&M University*

W. Herbert Wilson, Jr.  
*Colby College*  
Jeffery S. Wooters  
*Pensacola Junior College*  
Jennifer L. Wortham  
*University of Evansville (Indiana)*  
Janie L. Wulff  
*Florida State University*